

1 **AMENDMENTS TO THE CLAIMS**

2
3 **CLAIM LISTING:**

4
5 Please amend claims 1-6, 9-11, 13-14, 16-17, 22, and 25 as follows:

6
7 1. (Currently amended) A method of snapshot operation for a data storage
8 system with a first host that communicates with a cache memory, a source ~~VLUN~~ Virtual
9 Logical Unit Number (VLUN) and a target VLUN, comprising:

10 generating first metadata to locate first snapshot data and to indicate when the
11 first snapshot data is in the target VLUN; and

12 generating second metadata to locate second snapshot data and to indicate
13 when the second snapshot data is in the target VLUN, wherein the first and second
14 metadata locate ~~the same data~~ an original data element of the first snapshot data and of
15 the second snapshot data at the same address in the target VLUN.

16
17 2. (Currently amended) The method of claim 1, wherein generating the first
18 metadata includes generating a first log file pointer to locate ~~first snapshot data~~ the
19 original data element in the target VLUN.

20
21 3. (Currently amended) The method of claim 2, wherein generating the first
22 metadata includes changing a first bitmap to indicate ~~first snapshot data~~ the original
23 data element has migrated to the target VLUN.

24
25 4. (Currently amended) The method of claim 1, wherein generating the
26 second metadata includes generating a second log file pointer to locate ~~second~~
27 ~~snapshot data~~ the original data element in the target VLUN.

28
29 5. (Currently amended) The method of claim 4, wherein generating the
30 second metadata includes changing a second bitmap to indicate ~~second snapshot data~~
the original data element has migrated to the target VLUN.

1 6. (Currently amended) A snapshot system for a data storage system
2 including a first host that communicates with a cache memory, a source ~~VLUN~~ Virtual
3 Logical Unit Number (VLUN), a target VLUN, and metadata, comprising:
4 a source VLUN for active data;
5 a target VLUN to store migrated snapshot data;
6 first metadata to indicate when and to locate where the first snapshot data is in
7 the target VLUN; and
8 second metadata to indicate when and to locate where second snapshot data is
9 in the target VLUN wherein the first metadata and the second metadata ~~to~~ indicate and
10 locate ~~the same~~ a data element common to the first and second snapshot data in the
11 target VLUN.

12
13 7. (Original) The snapshot system of claim 6, wherein the first metadata
14 includes a first log file pointer to locate the first snapshot data in the target VLUN and
15 the second metadata includes a second log file pointer to locate the second snapshot
16 data in the target VLUN.

17
18 8. (Original) The snapshot system of claim 6, wherein the first metadata
19 includes a first bitmap to indicate when the first snapshot data has migrated to the target
20 VLUN and a first log file to locate the first snapshot data in the target VLUN, and the
21 second metadata includes a second bitmap to indicate when the second snapshot data
22 has migrated to the target VLUN and a second log file to locate the second snapshot
23 data in the target VLUN.

24
25 9. (Currently amended) The snapshot system of claim 6, wherein ~~the~~ a first
26 bitmap and ~~the~~ a second bitmap indicate that the first snapshot data and the second
27 snapshot data have migrated to the target VLUN.

28
29 10. (Currently amended) The snapshot system of claim 6, wherein ~~the~~ a first
30 log file and ~~the~~ a second log file locate the first snapshot data and the second snapshot
data that have migrated to the target VLUN.

1 11. (Currently amended) The snapshot system of claim 6, wherein the first
2 metadata and the second metadata indicate some of the first and second snapshot data
3 remain in the source VLUN.

4
5 12. (Original) The snapshot system of claim 6, wherein the first metadata
6 indicates that the original data of the first snapshot is in the target VLUN and the second
7 metadata indicates that the original data of the second snapshot is in the source VLUN.

8
9 13. (Currently amended) The snapshot system of claim 6, wherein ~~the~~ a first
10 log file and ~~the~~ a second log file each include a pointer identifying the ~~same data~~
11 ~~location~~ address of the common data element in the target VLUN.

12
13 14. (Currently amended) A method of destaging of data of one or more
14 snapshots to maintain data consistency of original data between a cache memory and a
15 target VLUN Virtual Logical Unit Number (VLUN) of a data storage system, comprising:
16 reading ~~the~~ bitmaps for all of the snapshots into a first host memory;
17 reading ~~the~~ log files for all of the snapshots into the first host memory;
18 searching the bitmaps to identify snapshots that require the original data to be
19 destaged;
20 destaging the original data to an available location in the target VLUN;
21 updating each log file associated with the identified bitmaps by adding pointers to
22 the original data located in the target VLUN; and
23 updating each associated bitmap to indicate completion of the destage operation
24 to the target VLUN.

25
26 15. (Original) The method of claim 14, further comprising searching the
27 bitmaps for the presence of original data in the target VLUN, determining the next
28 available target address for the next destage operation, checking the cache memory to
29 see if other original dirty data needs to be destaged to the target VLUN and if so,
30 identifying additional snapshots requiring original data to be destaged and if not, writing
updated bitmaps and log files to the target VLUN.

1 16. (Currently amended) The method of claim 14, further comprising writing
2 the log file files and the ~~bitmap~~ bitmaps to the target VLUN, removing ~~the a~~ dirty data
3 designation for the destaged original data still in the cache memory and ~~completing the~~
4 ~~target destage operation~~ sending destage operation complete status.

5
6 17. (Currently amended) A method of snapshot operation in a data storage
7 system in a first host that communicates with a cache memory, a source ~~VLUN~~ Virtual
8 Logical Unit Number (VLUN), a target VLUN, first metadata, and second metadata,
9 comprising:

10 receiving requests from an application to modify data in the cache memory;
11 writing the modified data to the cache memory;
12 destaging the original data to the target VLUN to preserve the original data of a
13 first snapshot and a second snapshot; and
14 updating the first and second metadata to locate the original data common to the
15 first and second snapshot in the target VLUN.

16
17 18. (Original) The method of claim 17, further comprising destaging the first
18 and second metadata to the target VLUN.

19
20 19. (Original) The method of claim 17, further comprising updating the first
21 and second metadata to indicate the presence of the destaged original data in the target
22 VLUN.

23
24 20. (Original) The method of claim 19, further comprising destaging the first
25 and second metadata to the target VLUN.

26
27 21. (Original) The method of claim 17, further comprising destaging the
28 modified data in the cache memory to the source VLUN to maintain data consistency.
29
30

1 22. (Currently amended) A method of snapshot operation in a data storage
2 system in a first host that communicates with a cache memory, a source ~~VLUN~~ Virtual
3 Logical Unit Number (VLUN), a target VLUN, a plurality of bitmaps, and a plurality of log
4 files, comprising:

5 receiving requests from an application to modify data in the cache memory;

6 writing the modified data to the cache memory;

7 destaging the original data to the target VLUN to preserve the original data of a
8 first snapshot and a second snapshot;

9 adding a pointer in a first log file to locate the original data in the target VLUN;

10 updating a first bitmap to indicate the presence of the destaged original data in
11 the target VLUN;

12 adding a pointer to the original data in a second log file to locate the original data
13 in the target VLUN; and

14 updating a second bitmap to indicate the presence of the original data in the
15 target VLUN.

16
17 23. (Original) The method of claim 22, further comprising destaging the
18 modified data in the cache memory to the source VLUN to maintain consistency.

19
20 24. (Original) The method of claim 22, further comprising destaging the first
21 and second bitmaps and the first and second log files to the target VLUN.

1 25. (Currently amended) A method of an error recovery process in a data
2 storage system wherein a first host verifies that original dirty data has or has not been
3 destaged to ~~the target VLUN~~ a target Virtual Logical Unit Number (VLUN), comprising:

4 (a) reading a bitmap, wherein if the bitmap contains a [0] value in a bit position
5 representing the original dirty data in cache memory, destaging the data to the target
6 VLUN, and wherein if the bitmap contains ~~a~~ an inverse value in [a] the bit position
7 representing the presence of ~~associated~~ the original data in the target VLUN, not
8 destaging the data;

9 (b) removing the dirty data designation for the destaged data; and

10 (c) repeating the steps (a) and (b) until all of the original dirty data is destaged.

11
12 Please add new claims 26-32 as follows:

13
14 26. (New) A method of snapshot operation for a data storage system with a
15 first host that communicates with a cache memory, a source Virtual Logical Unit
16 Number (VLUN) and a target VLUN, comprising:

17 generating first metadata to locate first snapshot data and to indicate when the
18 first snapshot data is in the target VLUN, wherein generating the first metadata includes
19 generating a first log file pointer to locate first snapshot data in the target VLUN; and

20 generating second metadata to locate second snapshot data and to indicate
21 when the second snapshot data is in the target VLUN, wherein the first and second
22 metadata locate the same data in the target VLUN, and wherein generating the first
23 metadata includes changing a first bitmap to indicate first snapshot data has migrated to
24 the target VLUN.

1 27. (New) A method of snapshot operation for a data storage system with a
2 first host that communicates with a cache memory, a source Virtual Logical Unit
3 Number (VLUN) and a target VLUN, comprising:

4 generating first metadata to locate first snapshot data and to indicate when the
5 first snapshot data is in the target VLUN; and

6 generating second metadata to locate second snapshot data and to indicate
7 when the second snapshot data is in the target VLUN, wherein the first and second
8 metadata locate the same data in the target VLUN, wherein generating the second
9 metadata includes generating a second log file pointer to locate second snapshot data
10 in the target VLUN, and wherein generating the second metadata includes changing a
11 second bitmap to indicate second snapshot data has migrated to the target VLUN.

12
13 28. (New) A snapshot system for a data storage system including a first host
14 that communicates with a cache memory, a source Virtual Logical Unit Number (VLUN),
15 a target VLUN, and metadata, comprising:

16 a source VLUN for active data;

17 a target VLUN to store migrated snapshot data;

18 first metadata to indicate when and to locate where the first snapshot data is in
19 the target VLUN, wherein the first metadata includes a first bitmap to indicate when the
20 first snapshot data has migrated to the target VLUN and a first log file to locate the first
21 snapshot data in the target VLUN; and

22 second metadata to indicate when and to locate where second snapshot data is
23 in the target VLUN, wherein the first metadata and the second metadata to indicate and
24 locate the same snapshot data in the target VLUN, and wherein the second metadata
25 includes a second bitmap to indicate when the second snapshot data has migrated to
26 the target VLUN and a second log file to locate the second snapshot data in the target
27 VLUN.

1 29. (New) A snapshot system for a data storage system including a first host
2 that communicates with a cache memory, a source Virtual Logical Unit Number (VLUN),
3 a target VLUN, and metadata, comprising:

4 a source VLUN for active data;

5 a target VLUN to store migrated snapshot data;

6 first metadata to indicate when and to locate where the first snapshot data is in
7 the target VLUN; and

8 second metadata to indicate when and to locate where second snapshot data is
9 in the target VLUN wherein the first metadata and the second metadata to indicate and
10 locate the same snapshot data in the target VLUN, wherein the first metadata and the
11 second metadata indicate snapshot data remain in the source VLUN.

12
13 30. (New) A method of snapshot operation in a data storage system in a first
14 host that communicates with a cache memory, a source Virtual Logical Unit Number
15 (VLUN), a target VLUN, first metadata, and second metadata, comprising:

16 receiving requests from an application to modify data in the cache memory;

17 writing the modified data to the cache memory;

18 destaging the original data to the target VLUN to preserve the original data of a
19 first snapshot and a second snapshot;

20 updating the first and second metadata to locate the original data in the target
21 VLUN; and

22 destaging the first and second metadata to the target VLUN.

1 31. (New) A method of snapshot operation in a data storage system in a first
2 host that communicates with a cache memory, a source Virtual Logical Unit Number
3 (VLUN), a target VLUN, first metadata, and second metadata, comprising:

4 receiving requests from an application to modify data in the cache memory;
5 writing the modified data to the cache memory;
6 destaging the original data to the target VLUN to preserve the original data of a
7 first snapshot and a second snapshot;

8 updating the first and second metadata to locate the original data in the target
9 VLUN;

10 updating the first and second metadata to indicate the presence of the destaged
11 original data in the target VLUN; and

12 destaging the first and second metadata to the target VLUN.

13
14 32. (New) A method of snapshot operation in a data storage system in a first
15 host that communicates with a cache memory, a source Virtual Logical Unit Number
16 (VLUN), a target VLUN, first metadata, and second metadata, comprising:

17 receiving requests from an application to modify data in the cache memory;
18 writing the modified data to the cache memory;
19 destaging the original data to the target VLUN to preserve the original data of a
20 first snapshot and a second snapshot;

21 updating the first and second metadata to locate the original data in the target
22 VLUN; and

23 destaging the modified data in the cache memory to the source VLUN to
24 maintain data consistency.